INTERNET DOCUMENT INFORMATION FORM

A. Report Title: Space-Based Infrared System – Supportability Engineering and Acquisition Reform In An Existing Acquisition Environment

B. DATE Report Downloaded From the Internet: October 18,1999

C. Report's Point of Contact: (Name, Organization, Address, Office Symbol, & Ph #): DEPARTMENT OF THE AIR FORCE
AIR FORCE JOURNAL OF LOGISTICS
501 WARD STREET
GUNTER ANNEX
MAXWELL AFB, AL 36114-3236

D. Currently Applicable Classification Level: Unclassified

E. Distribution Statement A: Approved for Public Release

F. The foregoing information was compiled and provided by:
DTIC-OCA Initials: __pm__ **Preparation Date OCTOBER 18, 1999**

The foregoing information should exactly correspond to the Title, Report Number, and the Date on the accompanying report document. If there are mismatches, or other questions, contact the above OCA Representative for resolution.

Space-Based Infrared System—Supportability Engineering and Acquisition Reform in an Existing Acquisition Environment

Richard J. Fickes
Kenneth A. Good, PhD

The Space-Based Infrared System (SBIRS) is a consolidated, cost-effective, flexible system designed to meet US infrared global surveillance needs through the next several decades. It uses a streamlined acquisition approach to develop and field an integrated *system of systems* including multiple space constellations and an evolving reparable and redundant ground segment. SBIRS is being developed in three increments. Figure 1 depicts the final SBIRS architecture consisting of a Space

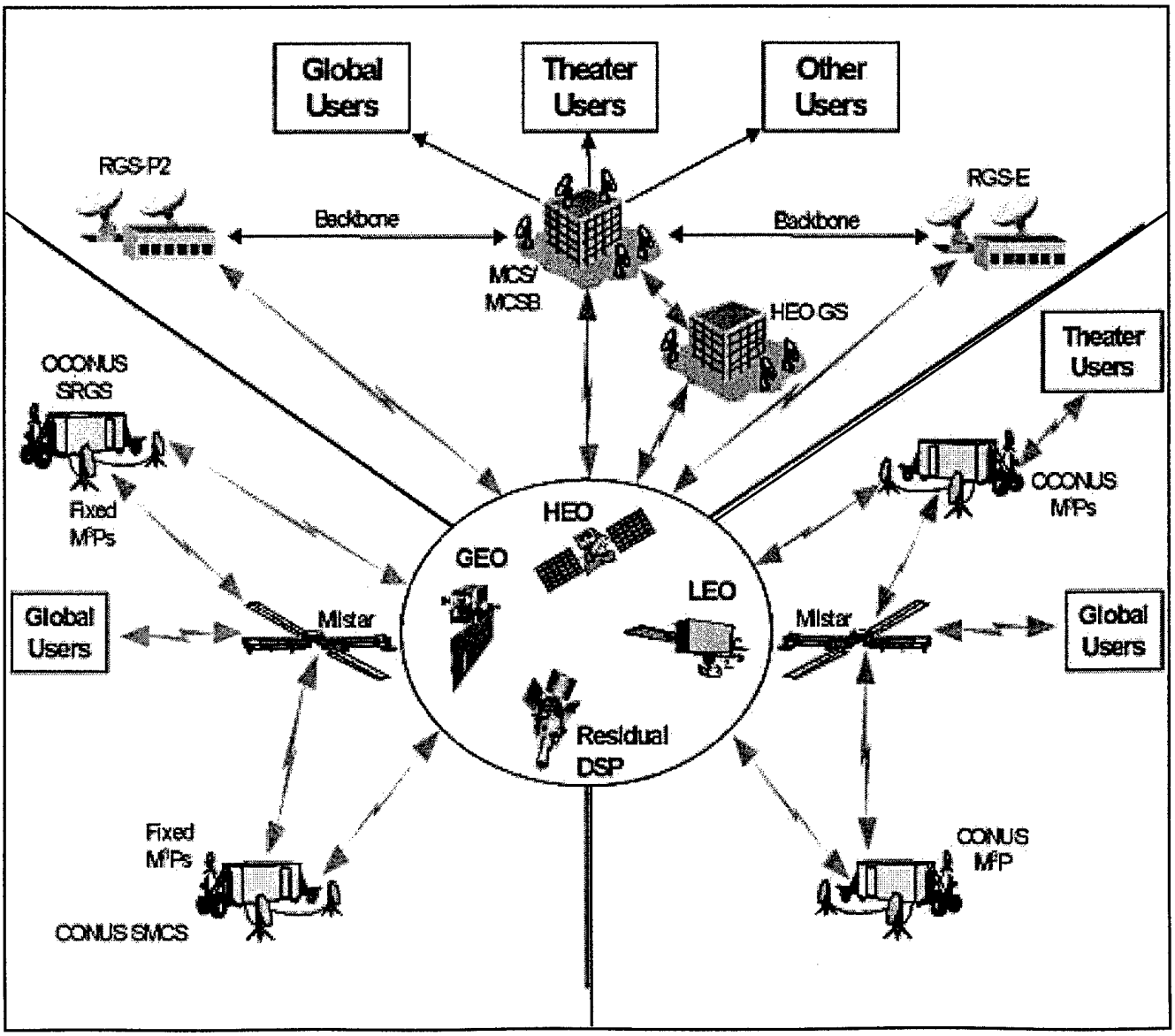

Figure 1. SBIRS Architecture

Segment with Geosynchronous Earth Orbit, Highly Elliptical Orbit, Low Earth Orbit and residual Defense Support Program satellites and sensors. The Ground Segment consists of *peacetime* elements, theater/endurable elements and survivable elements. The primary Ground Segment assets include the Mission Control Station, Relay Ground Stations, and Mobile Multi-Mission Processors with backups. SBIRS is the *flagship* program of Air Force acquisition reform for procuring a large, complex space system.

This article discusses supportability requirements definition and the implementation of supportability engineering in SBIRS evolution from an Integrated Product Team (IPT) aspect. The discussion includes experience and lessons learned from the logistics infrastructure acquisition during the Engineering, Manufacturing and Development (EMD) phase. SBIRS supportability acquisition is occurring under the umbrella of the Department of Defense *new acquisition reform*, IPTs and Total System Performance Responsibility (TSPR). IPTs are the key management, issue resolution and interaction avenues between the user (Air Force Space Command [AFSPC]), the System Program Office (SPO) (Space and Missile Center [SMC]) and the contractor (Lockheed Martin). This article details the actual roles and responsibilities of the user, program office and contractor with the intent to demonstrate how supportability engineering in an existing acquisition reform environment really functions. SBIRS is the first program to be acquired under this trinity of government initiatives. It is, therefore, in a pathfinding mode with respect to discovering what these initiatives really mean on a day-to-day basis and how they affect the working relationships among the SBIRS community—SMC; AFSPC; government System Engineering and Technical Assistance (SETA) contractors and the SBIRS Ground Segment contractor, Lockheed Martin.

As the user representative, AFSPC is responsible for operational and supportability requirements development, definition and clarification. Specific performance-based supportability requirements are defined and documented in the SBIRS Operational Requirements Document. With the program now in the EMD phase, AFSPC maintains a disciplined requirements review process, as depicted in Figure 2, to accept and evaluate potential new SBIRS requirements from the user community. Potential requirements changes are rigorously evaluated by the user working groups, AFSPC, SPO and Lockheed Martin before possible acceptance. The basic goal of this disciplined requirements process is to preclude the *requirements creep* experienced by past acquisition programs.

Current SBIRS supportability requirements are developed in accordance with Air Force acquisition reform tenets. No military standards or specifications are used to define supportability engineering requirements or state compliance. All documented supportability engineering requirements are *performance-based* statements reflecting a need rather than a solution. Reaction from the user requirements community concerning the new paradigm of performance-based requirements was decidedly mixed, ranging from one extreme to the other. One response, particularly from the operational community, was that the supportability engineering requirements were too long. One page *we need supportability* was deemed sufficient. The other extreme, primarily from the *old*

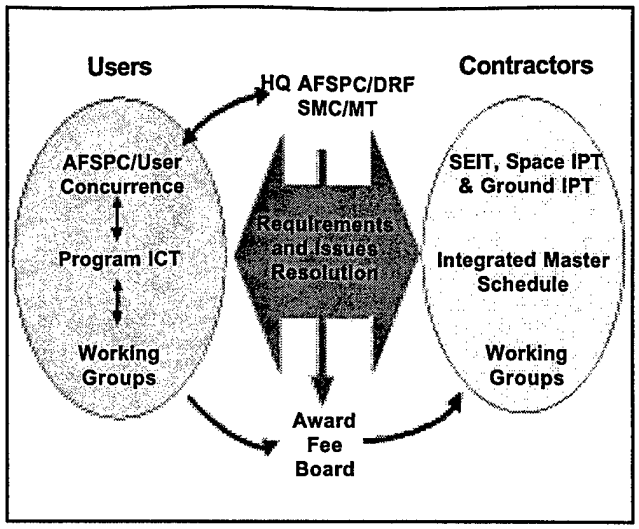

Figure 2. Requirements Review Process

supportability community, was that the new requirements were not sufficiently detailed. That community consistently wanted to state requirements as solutions rather than needs. The final version of supportability engineering requirements documented in the SBIRS ORD are a complete, balanced and performance-based set of stated AFSPC needs that do not stipulate solutions. The SBIRS contractor is allowed the flexibility to develop innovative contractor solutions to AFSPC needs without the limitations of military standards, military specifications or military processes. The AFSPC Directorate of Requirements for Force Enhancement-Sensors (DRFS) evaluates and monitors the contractor's proposed solutions to ensure the stated SBIRS needs are met.

Another major paradigm shift in the definition of operational requirements and metrics is the SBIRS Operational Dependability (D_o) parameter. D_o, rather than the more commonly used Operational Availability (A_o), is the key driving supportability factor for SBIRS and is considered an element of system performance. A_o is a function of nonmission time, however, SBIRS is a 24-hour a day, 7-day a week, 365-day a year operating system. There is no nonmission time. D_o is a function of mission time and quantifies the probability that once the system is turned on it will remain on and reliably perform its stated mission.

AFSPC/DRFS created Integrated Concept Teams (ICTs) to bring together the SBIRS user and operator communities to discuss and monitor major SBIRS issues, including supportability engineering. Three ICTs (Space, Ground and Program) exist as the forum for discussion and issue resolution. These three ICTs correspond to and interact with the Space and Ground IPTs and the System Engineering and Integration Team. During the EMD Phase, AFSPC participates in the ICTs and IPTs, provides requirements clarification to the SPO and Lockheed Martin and evaluates contractor performance through the award fee process. At the AFSPC level, an Integrated Logistics Support (ILS) Working Group is a subset of the Ground ICT to specifically work and monitor supportability engineering issues for AFSPC. At the contractor level, an ILS IPT is a subset of the Ground IPT. Representatives from each team serve on both the ICT and IPT to ensure interaction and coordination. The interaction of the various teams is depicted in Figure 3.

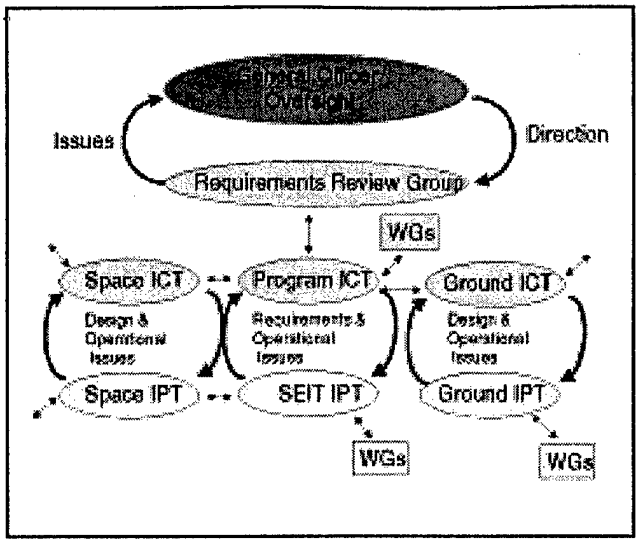

Figure 3. Team Interactions

The SPO manages the program to procure SBIRS according to the agreed-upon schedule and delivery dates and within budget and staffing resources allocated to the program. The SPO performs contract monitoring, participates in all ICTs and IPTs and administers the award fee process. The award fee is a critical element of the acquisition process. It is designed to provide incentives for innovative contractor management and engineering. SMC/MTL is the office specifically responsible for ensuring that all supportability requirements are integrated as system performance parameters and accomplished IAW the agreed-upon schedule and levels of performance quality.

The 9 February 1996 Secretary of Defense acquisition reform mandate directed maximum program streamlining and encouraged the maximum use of existing commercial equipment, infrastructure and processes to save acquisition time and resources. This mandate dovetailed nicely with both the SBIRS acquisition strategy and the long-held contention of major defense contractors that great savings would be possible if they were unburdened by specifications, standards and reprocurement competition. Under the TSPR adopted by SBIRS, the SPO manages the overall SBIRS program and retains responsibility for requirements definition, operational system acceptance and mission assurance to AFSPC. Requirements are generally defined with *performance specifications* rather than the traditional array of government specifications and standards. Lockheed Martin has wide latitude in meeting the prescribed parameters. They assume *total responsibility* for the design, development, integration, test, delivery and sustainment of the new system. Other space oriented systems have employed TSPR-like concepts but only up to the Operational phase. It is the continuation of contractor responsibility for sustainment into the Operational phase, and potentially for the life of the system, that makes this approach unique. TSPR is a dimension beyond traditional contractor logistics support (CLS) since the support system infrastructure remains with the contractor who provides both depot- and organization-level support in a sole-source environment.

The SBIRS program uses performance specifications and nongovernment standards in lieu of military specifications and standards, unless required. Under TSPR, Lockheed Martin is given maximum flexibility to conduct the program efficiently while still providing the government with clear visibility into cost, schedule, technical performance and risk. In turn, Lockheed Martin is responsible and accountable for their performance. As the total system integrator, they assume TSPR as outlined in the performance requirements of the contract. Their responsibilities include: (1) performing system of systems performance analysis and design; (2) providing timely insight into SBIRS program status including ongoing risk assessment and risk management measures for all technical, cost and schedule aspects of the total program and identification of problems, development of alternative solutions and recommendations for implementing proposed solutions. The cornerstone of the SBIRS program is effective control of the life-cycle sustainment cost for the ground segment while meeting system performance requirements. The SPO focuses on managing the SBIRS TSPR program through *insight* under the auspices of streamlined acquisition.

The management philosophy under TSPR is through effective use of ICTs, contractor-led IPTs and the award fee incentive. Since Lockheed Martin is providing a system that will be operated on an Air Force installation, by Air Force personnel and will interface with other Air Force and government systems, participation by technical personnel from the SPO, AFSPC and supporting commands on AFSPC-led ICTs and Lockheed Martin-led IPTs is a major key to success. This environment enhances the relatively unfettered flow of information to both government and Lockheed Martin decision makers. In order to maintain program baseline stability under performance-based contracting, IPTs are used to manage the requirements process while Cost as an Independent Variable (CAIV) and life-cycle cost reductions are the primary focus of the award fee process.

Traditional roles, responsibilities and authority of the program office are transferred to Lockheed Martin. The primary means of communicating Lockheed Martin progress and interfacing with the user is through the IPT. IPTs, in this sense, are not only for status updates but also a forum for bringing up issues; discussing, identifying and developing solutions; and assigning action items to members—unlike the traditional IPT approach where the government typically leads, identifies problems, directs solutions and approves contractor solutions. Under TSPR, action items may be and are regularly assigned to government representatives, and the entire team owns the issues. Various working groups within the IPTs continually balance cost, schedule and technical performance against performance requirements.

The SPO's challenge is to keep requirements growth in check. Requirements are derived from performance specifications as stated in the SBIRS ORD and allocated to Ground Segment and Space Segment specification. In order to manage requirements growth/changes, the program has implemented requirements management processes where the appropriate segment IPTs validate changes to the SEIT, which in turn are validated in the MIPT. The single voice from the user community is HQ AFSPC/DRFS. Ultimately, changes must be *blessed* by AFSPC/DRFS who owns the basic requirements and controls the *checkbook*. Many new requirements and improvements are discussed at the working level, with most being eliminated at this stage. Ultimately, the Management IPT—composed of Lockheed Martin senior managers, the SPO program manager and HQ AFSPC/DRFS—

controls the change process.

The award-fee process is another method to control change by incentivizing the contractor to meet performance requirements in cost and on schedule. The award fee plan awards Lockheed Martin a maximum award fee of 20 percent for each evaluation period. The fee pool is broken out as follows: cost 50 percent of fee pool, technical management 45 percent of fee pool and management 5 percent. The award fee pool emphasizes performance-based contracting with the most emphasis on cost control. Prior to entering each award fee period, Lockheed Martin enters into agreements with the government IPT members to identify expectations and accomplishments within the constraints of the Integrated Master Plan. Their performance is motivated by both positive and negative incentives. Positive incentives include a significant award-fee pool and the opportunity to share in documented life-cycle cost savings. On the negative side, they must meet specific performance criteria and must not breach an established cost ceiling. Failure in either area will cause the government to demand delivery of a reprocurement data package within 12 months and result in loss of sole source sustainment. Although the negative aspects are key to this TSPR strategy, AFSPC retains some trepidation, believing business decisions may take precedent over the judgment of the operational commanders. The key challenges to successfully implementing TSPR sustainment facing government IPT members are:

- Establishing and tracking the operations and maintenance baseline.
- Validating life-cycle cost reductions.
- Documenting ceiling increases.
- Effectively managing the award-fee processes.

As the contractor, Lockheed Martin has TSPR for the entire life cycle of SBIRS. They are responsible for the development, deployment and sustainment of SBIRS. Lockheed Martin has the maximum possible flexibility to define schedule tasks, subject to operational need dates, and remains responsible and accountable for meeting contractual milestones. They are also responsible for the transition of user requirements to contract specifications. Lockheed Martin determines the supportability design parameters that control metrics and affect system design, evaluate supportability options and allocate critical supportability parameters to SBIRS subsystems. They establish the processes to control the supportability design parameters and achieve operational objectives. Lockheed Martin's requirements resolution process provides for response to changes; continuous improvement; analysis, test, and fixes and identification of potential variances and corrective actions. Supportability parameters are documented in the appropriate specifications, controlled through their configuration control process and electronically available to Lockheed Martin personnel, the SPO, and users through the CALS-compliant Sustainment Online Database and Electronic Data and Management System databases. Lockheed Martin participates in all the ICTs and IPTs to resolve issues and provide the government with adequate visibility into schedule and other issues so that the SPO and AFSPC can make independent assessments of program status and schedule risks and understand Lockheed Martin's projections of schedule milestones and other events. Figure 4 shows the organization of the logistics (and specialty engineering) activities within the Integration, Assembly, Test and Checkout team and the relationship of these activities to the other IPTs. Figure 5 displays the manner in which logistics and the related disciplines integrates the new acquisition initiatives and CAIV into both the system design and the support infrastructure.

Perhaps the most striking features of the new acquisition initiatives and TSPR for government and contractor logistics engineers reared in the classical DoD acquisition processes

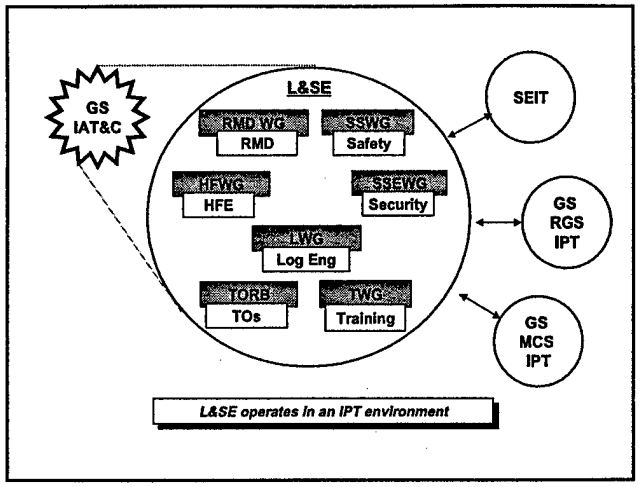

Figure 4. Integration, Assembly, Test and Checkout Logistics and Specialty Engineering Activities

are Lockheed Martin's:

- Freedom to determine supportability engineering tools and processes.
- Openness with the government and their SETAs.
- Interaction with the government in two distinct roles.
- Involvement of government personnel in the development of the system.
- Increased level of responsibility for the overall operation and maintenance of the system.

To begin with, it is obvious that, in order to acquire the supportability infrastructure for any system, the same set of supportability functions has to be completed (for example, support and maintenance concepts have to be enunciated, spares lists developed, spares ordered, maintenance procedures written, staffing levels and profiles derived and technical manuals and training courses generated). The trinity of government acquisition initiatives (reform, IPTs and TSPR) does not change this list of functions. However, some of their features allow Lockheed Martin to determine the depth to which each supportability function will be performed for SBIRS.

New acquisition reform has a major impact on supportability engineering because it allows CLS (or as Lockheed Martin calls it, Contractor Sustainment) at the operational sites as well as at the depot and the use of commercial-off-the-shelf equipment. In the development of the Logistics Support Analysis (LSA), many of the tables that are traditionally generated to ensure effective service through the

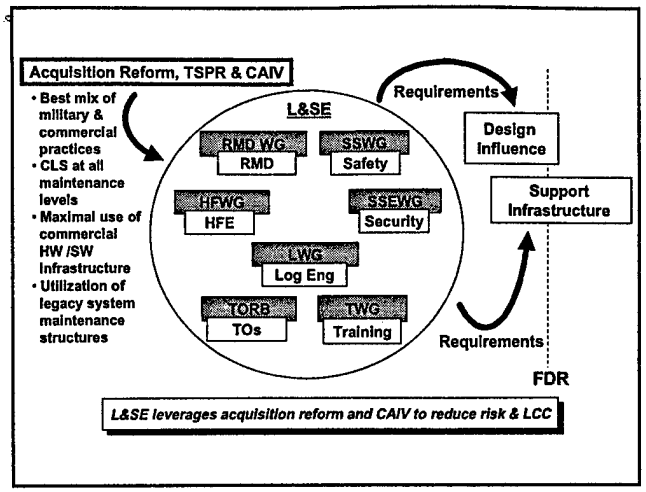

Figure 5. Logistics and Specialty Engineering Approach

government supply support and depot systems are not developed for SBIRS. Although a database tool is utilized as a repository for LSA data, it will not be kept current for the duration of the SBIRS life cycle. The database will be retired shortly before the Increment 1 Initial Operational Capability and kept for reference only. All the usual data required for sustainment of the system will be kept in a database tailored for this purpose from a commercially available database application. In fact, if Lockheed Martin had known at the beginning of the program what they know today, they most probably would have tailored a commercially available spreadsheet for the LSA. Under acquisition reform and TSPR, such enormous freedom is afforded to implement processes that are creative and efficient. This freedom is handled with care to ensure no significant risks are added to SBIRS supportability engineering by enthusiastic implementation of untried and unproved, *good sounding* ideas.

Similarly, IPT changes the supportability engineering landscape. There exists a distinction between IPT *the meeting* and IPT *the process*. The former refers to the monthly or bimonthly status meetings with large attendance from the acquisition and user communities. While important in their own right, these gatherings usually end up as a series of briefings to keep the larger community up to speed. On the other hand, the IPT process is what happens the rest of the time and includes the myriad of Lockheed Martin internal team working sessions as well as the equally numerous Lockheed Martin-government problem-solving meetings.

As the *acquisition reform flagship* program and pathfinder for many of the acquisition reform processes, SBIRS encounters new lessons learned on a continual basis. Internal to the contractor team, Lockheed Martin has witnessed working relationships that have been extremely productive and delivered supportability products in almost unheard of short periods of times. For example, prior to the final design review (FDR) for SBIRS Increment 1, the development of the engineering drawing package was expedited by employing the IPT process. Lockheed Martin abandoned the time-consuming method of employing a serial process in which each team member reviews the engineering drawings individually, sends comments forward to a joint meeting for adjudication, iterates the process until all issues are resolved and then sends the engineering drawings forward to a configuration control board (CCB) for final approval. In its place, Lockheed Martin gathered all of the decision makers, including product control and key working system and supportability engineers, in a *virtual forum* tied together by phone and teleconference lines so all the companies on the Lockheed Martin SBIRS team were represented. Engineering drawing set problems were identified, solutions generated in real time and corrections made as rapidly as possible. In the few cases when disagreements grew heated, the program manager, who was the IPT leader, took the parties outside the room and spoke with them individually to help reach consensus. In this way, the chaos often inherent in such a large meeting was minimized. A CCB was convened as soon as the corrections were in place, and the engineering drawing set was rapidly approved, almost without a change, because of the earlier group effort. This effort, which occurred over a 5-day period and involved more than 200 drawings, ensured a high-quality drawing package for the FDR. It could never have been done the old serial way. Even IPT skeptics were impressed by results that were obtained by this process. Supportability engineers were an integral part of the effort to ensure supportability requirements were integrated into system design from the beginning.

The familiar, almost traditional, adversarial relationship between the contractor and the acquisition and user communities is replaced in the IPT process with a working relationship characterized by extreme openness and user involvement. Supportability and specialty engineering weekly staff meetings are attended by representatives of both the acquisition and user communities to ensure requirements are satisfied, monitor development progress and resolve issues. The meeting format is a review and status of the *top ten* issues in each of the specialty engineering disciplines, logistics, technical manuals and training. All issues, even the ones that are going badly or pose risk to the program, are presented. Lockheed Martin literally *airs the dirty wash in public*—a significant paradigm shift from previous practices and relationships. Their gain from the process is the development of the quintessential IPT in that it builds new levels of trust and joint Lockheed Martin-government problem solving and issue resolution to produce a cost-effective, operational system on time and within budget constraints. The acquisition and user supportability communities are a true continual part of the Lockheed Martin SBIRS supportability engineering team.

One benefit of this process is that an extremely close working relationship grows among the government and Lockheed Martin SBIRS team members. All participants take ownership in the product. This involvement has exhibited itself in the joint resolution of supportability issues and development of key presentations by Lockheed Martin, the SPO, AFSPC and SETA personnel. It is no surprise for Lockheed Martin employees to see their peers working late nights to get a required supportability engineering product completed. The IPT process fosters Lockheed Martin employees and SETA counterparts working together for several days and late nights to complete a project. As a team, they resolved issues and ensured that a particular supportability engineering presentation would accurately present all facets of the issue and joint resolution recommendations. Nothing in Lockheed Martin's previous experience with the acquisition process resembles this effort.

For another example of the involvement that is fostered by the IPT process, one need only look at the technical manual or technical order (TO) generation activities. Lockheed Martin has employed a standard 30 percent, 60 percent and 90 percent in-process review plan to review all developed TOs. To increase the insight of the user command into the form and content of the TOs at an early stage, they have involved a team of AFSPC operators as reviewers and developers of certain portions of the TOs (for example, high level checklists) during development and validation. Lockheed Martin and some users did not initially embrace this concept because it was felt it would be disruptive to the TO generation effort and the users did not fully understand their role under the umbrella of acquisition reform and IPTs. The SPO and AFSPC/DRFS pushed very hard for this early operator involvement, and it has proved itself to be extremely valuable. Procedures and checklists are developed by a joint Lockheed Martin TO development team and the AFSPC personnel programmed as the initial SBIRS crews. This is a superior example of a *true* IPT.

Although the IPT process can foster a contractor-government-SETA relationship on a program, there are at least two other aspects of the relationship with the government that should not be overlooked. First of all, Lockheed Martin must continually remember that these same government IPT members who jointly help to solve the day-to-day issues are also the same government employees that grade performance at award fee time. This grading process is now performed with contractor-government openness as a key criterion (usually referred to as quality of government insight) alongside the more usual ones. Although there is a risk of being penalized because of the government insight gained due to the new openness, Lockheed Martin supportability engineering has not been adversely impacted by the government's insight on SBIRS. In fact, Lockheed Martin has benefited tremendously in its efforts to deliver a supportable SBIRS. The second item in the relationship with the government is the fact that the government is a collection of nonhomogeneous agencies that do not all accept, adhere to, understand or even know of the trinity of government acquisition reform initiatives. In SBIRS experience, it has been very probable that at least one or more of the agencies with which Lockheed Martin works is still under the influence of the old acquisition paradigm or simply does not understand the significant impact of integrated supportability engineering. This situation has been eased frequently, somewhat, by those acquisition and user agencies that subscribe to and are a part of the new acquisition reform, IPT and TSPR community. This community helps enlist those recalcitrant or unknowing agencies into the new fold. Lockheed Martin, the SPO and AFSPC interface continually with these *old line* agencies to ensure good communication and requirements compliance.

In summary, several examples have been presented that show how logistics engineering activities are performed in the environment fostered by the government's new acquisition initiatives. These initiatives offer great opportunities for the use of novel and money-saving ways of developing the sustainment infrastructure in space systems. Supportability engineers will need to be flexible in their approaches to the technical effort, as well as their relationships with the customer, users and SETAs, to reap the benefits inherent in the government's new approach. SBIRS has broken new ground in the acquisition reform, IPTs and TSPR arenas. Challenges still exist, and the entire team is still experiencing varied *lessons learned* on a continual basis. SBIRS supportability engineering is an integral part of the process and contributes heavily to the successful requirements definition, design, development and deployment of the system.

References

1. Blanchard, Benjamin S., "A Vision for Logistics Support Planning," *Logistics Spectrum*, May/June 1997.
2. Blanchard, Benjamin S., Ralph Giffin, III, Erich Hauser and Benjamin Ostrofsky, "Future of Supportability Engineering," Panel Discussion presented at SOLE 97, 32nd Annual Logistics Conference and Exposition, August 1997.
3. Coogan, Charles O., "Performance Based Support," Technical Workshop presented at SOLE 97, 32nd Annual Logistics Conference and Exposition, August 1997.
4. Cooper, Pamela S., "Logistics Reform - Challenging the Status Quo," Technical Paper presented at SOLE 97, 32nd Annual Logistics Conference and Exposition, August 1997.
5. Giffin, Ralph, III and Dinesh Verma, "Supportability for COTS," Technical Tutorial presented at SOLE 97, 32nd Annual Logistics Conference and Exposition, August 1997.
6. Knezevic, Jezdimir, "Supportability Engineering and System Effectiveness," Technical Paper presented at SOLE 97, 32nd Annual Logistics Conference and Exposition, August 1997.
7. Rogers, Steve C., "Performance Based Supportability Analysis—A Success Story," *Logistics Spectrum*, May/June 1997.
8. Shelton, Raymie O., "The IPPD and IPT Approach to Logistics," *Logistics Spectrum*, May/June 1997.
9. Smith, Caroline, and Jezdimir Knezevic, "Supportability Analysis of Repairable Systems with Parallel Configurations," Technical Paper presented at SOLE 97, 32nd Annual Logistics Conference and Exposition, August 1997.
10. Space-Based Infrared System Single Acquisition and Management Plan, 18 July 1997.

Richard J. Fickes is a Senior Logistics Engineer for System Technology Associates supporting the AFSPC Directorate of Requirements. Kenneth A. Good, PhD, president of Good Engineering, Inc., is the Technical Leader for SBIRS Ground Segment Logistics and Specialty Engineering at Lockheed Martin Missile Systems.

A military maxim has it that amateurs talk about strategy while professionals talk about logistics.

—Time Magazine, August 1990